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(54) Method of processing tire cord fabric, and tire so obtained.

(57) Tire cord fabric 10 is processed by supporting a section 26 of fabric 10 and adjusting the warp cords 12 to hang so that they are evenly distributed in a longitudinal direction. The fabric 10 is then clamped in place and a dilute reactive polyurethane solution is sprayed to wet the cords 12, 14 on both sides of the fabric 10 so that the coating on the cords 12, 14 is extremely thin and acts as a sizing material for the fabric 10 to give it dimensional stability and preserve the interstices 76 of the cords 12, 14. The fabric 10 is then heated to evaporate the solvent and cause the polyurethane mixture to be at least partially cured and to at least partially cover the cords 12, 14 of the fabric. The treated fabric 10 may be used to reinforce a cast polyurethane tire 78.

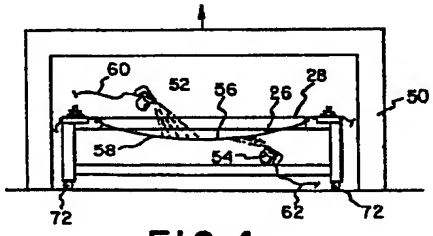

FIG. 4

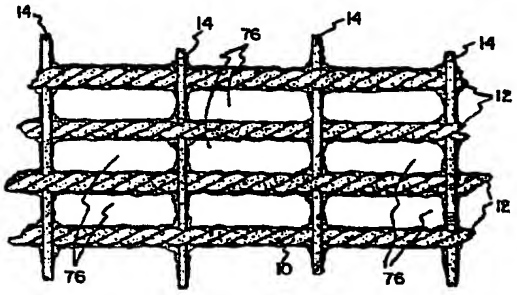

FIG. 6

EP 0 106 778 A1

TITLE MODIFIED
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METHOD OF PROCESSING TIRE CORD FABRIC

This invention relates to the processing of cord fabric and especially to the processing of tire fabric to obtain dimensional stability so that the fabric can be cut to size and used as a cord belt in a tire which is formed by a suitable casting operation such as spin casting. In one application the cut and treated fabric is placed on the inside of a precast polyurethane tread and held in place in the mold while the remainder of the tire is poured or spin cast.

It has been found that in order to properly adhere the tire fabric to the precast polyurethane tread and to have the fabric stay in position during the spin casting operation, the fabric must have a degree of dimensional stability. It has also been observed that a tire fabric made of nylon, polyester, or flexten treated with resorcinol formaldehyde latex typically does not have the necessary properties to provide a satisfactory chemical or mechanical bond to the polyurethane body of the tire.

With the method of this invention a tire fabric is given dimensional stability by applying a thin coating to the cords and thereby facilitating handling and resisting distortion during the casting process. The thin coating of the cords permits later penetration of the tire body material (polyurethane) into spaces between the cords and into the interstices of the cords to provide a mechanical bond. There is also apparently a chemical reaction between the polyurethane coating material and the polyurethane body

material of the tire providing a chemical bond. The result has been observed to be a satisfactory adhesion of the fabric to the body material of the tire due to the mechanical and chemical bonds.

In accordance with one aspect of the invention there is provided a method of processing tire cord fabric comprising (a) supporting a section of said tire fabric; (b) adjusting the support of the cords of said fabric so that the cords are evenly distributed in a longitudinal direction; (c) coating said fabric on both sides with a dilute reactive polyurethane solution to provide a coated fabric; (d) heating said coated fabric at a predetermined temperature for a predetermined time to evaporate the solvent and cause the polyurethane mixture to be at least partially cured and to at least partially cover the cords of the fabric; and (e) cooling said coated fabric.

In accordance with another aspect of the invention there is provided a tire made by molding a toroidal shaped pneumatic tire comprised of a radially outer tread portion, a reinforcing tire cord belt underlying said tread portion and a tire casing underlying said tread portion and said belt, said method including the steps of the above method for processing said tire cord fabric of said tire cord belt, and the steps of (a) forming said tread portion by placing elastomer-forming material in a space at the radially outer portion of said mold and molding, reacting and at least partially curing said material; (b) positioning said cord belt on the inside surface of said tread portion with the edges equidistant from a centerplane

of said tire; (c) fastening said cord belt to said tread portion with fastening means; (d) assembling and inserting a core member in said mold; (e) forming said casing by introducing and rotationally casting a predetermined quantity of liquid reaction mixture of elastomer forming material into the space between said core, said mold and said tread portion, reacting and at least partially curing said mixture to form said casing overlapping and integrally adhered to said reinforcing cord belt and said tread portion; and (f) removing said formed tire and core from said mold and removing said core from said tire.

It is most important that the resultant polyurethane coating of the cords be extremely thin so that it acts primarily as a sizing material for the fabric to give it a dimensional stability and does not fully encapsulate the fabric so that the interstices of the cords are essentially preserved.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principles of the invention may be employed.

In the drawings:

Fig. 1 is an enlarged fragmentary view of a section of the tire fabric before being treated.

Fig. 2 is a plan view showing a supply roll

of the fabric with a section clamped in a supporting frame for processing.

Fig. 3 is a sectional view taken along the line 3-3 of Fig. 2.

Fig. 4 is a schematic view showing the fabric being sprayed.

Fig. 5 is a schematic view of the oven showing the fabric being heated, with parts being broken away.

Fig. 6 is a fragmentary enlarged view of a portion of the fabric after being processed showing the thin coating connecting the warp and pick cords with the interstices and spaces between cords being open for mechanical bonding to the tire.

Fig. 7 is a cross-sectional view of a tire built in accordance with this invention.

Fig. 8 is a schematic cross-sectional view of a mold for casting the tire of Fig. 6 by centrifugal casting showing the collapsible core assembled in position in the mold.

Referring to Fig. 1, tire cord fabric 10 is generally loosely woven with warp cords 12 connected by pick cords 14 at spaced-apart intervals. The warp cords 12 are relatively thick and made from twisted strands or filaments and of a high strength material such as nylon, polyester or flexten. The pick cords 14 are relatively thin and made from a low strength material such as cotton. The tire cord fabric 10 is woven and then wound on a supply roll 16 shown in Figs. 2 and 3. The supply roll 16 may have a supporting shaft 18 with ends supported in bearings 20 on end supports 22 of a roll stand 24.

In accordance with the method of this invention, a section 26 of the tire cord fabric 10 is supported in a generally horizontal position on a frame 28 having transverse frame members 30 and 32, and spaced-apart longitudinal frame members 34 and 36 connected to the transverse frame members. The frame 28 also has supporting legs 38 which are connected by secondary frame members 40 as shown in Figs. 2 and 3.

Two transverse clamping bars 42 and 44 are provided for clamping the ends of the section 26 of tire cord fabric 10 against the transverse frame members 30 and 32. The clamping bars 42 and 44 may be of steel and have sufficient weight to hold the fabric 10 in position during the adjusting of the section 26 so that the warp cords 12 will hang with the same deflection or drape and are distributed evenly in a longitudinal direction across the width of the fabric. Holes are provided at the ends of the clamping bars 42 and 44 for sliding movement over studs 46 fastened to the transverse frame members 30 and 32 and extending upwardly therefrom. Nuts 48 may be threaded on the studs 46 for urging the clamping bars 42 and 44 against the transverse frame members 30 and 32 and thereby holding the ends of the section 26 of tire cord fabric 10 firmly in place. It is understood that the section 26 of tire cord fabric 10 may be supported in a vertical position with the warp cords 12 being distributed evenly in a longitudinal direction.

Referring to Fig. 4, an enclosed chamber such as a paint booth 50, which is vented for removing undesirable vapors, is shown with the frame 28 placed

therein after cutting the section 26 of tire cord fabric 10 from the supply roll 16. Aspirator type spray guns 52 and 54 for spraying a top surface 56 and a bottom surface 58 of the section 26 are shown. These guns 52 and 54 are connected by hoses 60 and 62 to a suitable source of air under pressure and have containers for holding the solution to be sprayed. When the section 26 is supported in a vertical position, the solution may also be sprayed on both surfaces 56 and 58.

Referring to Fig. 5, an oven 64, which may be of a steam heated type, is shown with the frame 28 and clamped section 26 of fabric 10 positioned within the oven for heating at a predetermined temperature for a predetermined time to evaporate the solvent in the solution and cause the mixture therein to at least partially cover the cords 12 and 14.

In accordance with the present invention, the untreated tire cord fabric 10 is wound on a supply roll 16 and supported on a roll stand 24 as shown in Figs. 2 and 3. A section 26 of the tire cord fabric 10 is pulled from the supply roll 16 and draped with the warp cords 12 extending in the longitudinal direction over the transverse frame members 30 and 32 of the frame 28. Preferably the width of the section 26 is less than the distance between the longitudinal frame members 34 and 36 to avoid any interference between the cord fabric 10 and frame 28.

The clamping bars 42 and 44 are laid over the top of the fabric 10 and hold the section 26 during adjustment for an even drape across the width of the section with the warp cords evenly distributed in

the longitudinal direction. If desired, strips of adhesive-backed foam tape 66 and 68 may be adhered to the contacting surfaces of the clamping bars 42 and 44 with the adhesive backing exposed for engagement with the cord fabric 10 so that the weight of the bars 42 and 44 will hold the fabric while it is adjusted to hang evenly across the width thereof. After the fabric 10 has been adjusted to hang evenly, the nuts 48 are threaded on the studs 46 and clamping bars 42 and 44 pressed tightly against the transverse frame members 30 and 32.

The section 26 of the tire cord fabric 10 may then be cut from the fabric on the supply roll 16 at a position close to the transverse frame member 30 to provide a section with a length corresponding to the length of a cord belt 70.

The frame 28 may have casters 72 so that it can be rolled into the paint booth 50 for spraying the top surface 56 and bottom surface 58 of the section 26 with a dilute reactive polyurethane solution prepared from a prepolymer and curative solution which may be, if desired, of the same material as a tire body 74 on which the cord belt 70 is to be used. The reactive polyurethane solution is sprayed through the spray guns 52 and 54 by filling the air gun bottles with the solution and connecting the air hoses 60 and 62 to a suitable source of air under pressure. The solution is then applied so as to merely wet the top and bottom surfaces 56 and 58 of the section 26 of the tire cord fabric 10.

Preferably the curative solution is added to

the prepolymer so that the ratio of amine groups of the curative to the free NCO groups of the prepolymer is in the range of from 0.8/1 to 1/1 with the free NCO groups being the excess of NCO groups of the polyisocyanate over the hydroxyl groups of the polymeric polyols in the prepolymer. The prepolymer is prepared separately by charging a reactor with a predetermined amount of polyol, degassing the polyol and then adding a required amount of diisocyanate to the degassed polyol at a predetermined temperature of about 212°F (100°C) under agitation with a full vacuum applied for a minimum period of time required to mix the diisocyanate and polyol.

The curative solution may be made by dissolving a predetermined amount of diamine curative such as Polacure solids in liquid ketone such as methylethyl ketone. For example, to 250 grams of prepolymer in a one-quart can an equal weight of 50/50 toluene/methylethyl ketone solvent mixture was added and then stirred until dissolved. The solvent mixture was prepared by dissolving Polacure (trimethyleneglycol di-para-aminobenzoate) 20% in methylethyl ketone.

Then the desired amount of curative solution was added to the prepolymer solution and thoroughly mixed. A dilute solution is preferred for spraying, although this is not critical, and may normally be twenty parts by weight of polyurethane reactive material based on one hundred parts by weight of the curative prepolymer solution. In this embodiment, this solution was sprayed on the cords 12 and 14 thinly and uniformly on both the top surface 56 and bottom surface 58 of the

tire cord fabric 10 in the section 26. Preferably the weight of the coating spray is only sufficient to wet the cords and bond the warp cords to the pick cords 14. It has been found that this has been achieved with the weight of the dry coating being in a range of from about 17 to 47 percent and preferably about 17 percent of the weight of the fabric.

The frame 28 and section 26 of tire cord fabric 10 are then rolled into the steam oven 64 and heated at a suitable temperature such as 200°F (93°C) for a suitable period of time such as one hour to evaporate the solvent and cause the polyurethane mixture to at least partially cover the cords 12 and 14 of the fabric 10.

After being heated the frame 28 is removed from the oven 64 and the section 26 of fabric 10 cut into cord belts 70 which may be four inches wide. This may be done by cutting the pick cords 14 between the warp cords 12 with a razor blade or scissors. Preferably the fabric 10 is left supported in the frame 28 until needed.

As shown in Fig. 6, the warp cords 12 and pick cords 14 are coated with a thin layer of reactive polyurethane solution leaving spaces 76 between the cords so that when this treated cord fabric 10 is later used in a tire construction such as a tire cast of polyurethane, the polyurethane material of the tire may flow into the spaces 76 and interstices of the cords to provide a mechanical bond. The mechanical bond is also improved because the low viscosity of the polyurethane solution facilitates penetration into the

spaces 76 between the cords 12 and 14 and interstices of the cords of the treated tire cord fabric 10. It has been found that the tire cord fabric 10 treated in accordance with this method has good dimensional stability and can be handled easily for positioning plies of the fabric in a tire 78 such as that shown in Figs. 7 and 8. It has also been found that the treated and cut fabric 10 in the form of the cord belt 70 can be placed on the inside surface 80 of a precast polyurethane tread 82 and held in place while the remainder of the tire 78 is poured or spin cast in a mold 84 by the steps shown and described in my copending patent application Serial No. 344,985, filed February 2, 1982. For example, with reference to Figs. 7 and 8, the tire 78 may be made by spin casting the tread 82 in the space at the radially outer portion of the mold 84 and then reacting and partially curing the material to form the tread 82 of a suitable polyurethane compositon. The cord belt 70, which is an intermediate type product for tire manufacture, is made in accordance with the process set forth hereinabove and positioned on the inside surface 80 of the tread 82 with edges 86 and 88 equidistant from a centerplane A-A of the tire 78. The cord belt 70 may be fastened to the inside surface 80 of the tread 82 by suitable fastening means. A core member 90 may be inserted in the mold 84, and the tire body 74 or casing formed by introducing and rotationally casting a predetermined quantity of liquid reaction mixture of elastomer forming material in a space 92 between the core, the mold and the tread 82. The elastomer forming material is reacted and at least

partially cured to form the tire body 76 of a suitable polyurethane composition overlapping and integrally adhered to the reinforcing cord belt 70 and the tread 82. The tire 78 and core 90 may then be removed from the mold 84 and the core removed from the tire.

Each of the cord belts 70 may also be made of two or more layers of treated fabric 10. When it is desirable, the layers may be cut on a bias with the warp cords 12 at an angle greater than zero degrees to the edges of one of the belts so that when the tire 78 is inflated the cords may pantograph and provide limited stretching of the belt.

While a certain representative embodiment and details have been described and shown for the purpose of illustrating the invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

WHAT IS CLAIMED IS:

1. A method of processing tire cord fabric 10 comprising

(a) supporting a section 26 of said tire fabric 10;

(b) adjusting the support 42, 44 of the cords of said fabric 10 so that the cords 12 are evenly distributed in the longitudinal direction;

(c) coating said fabric 10 on both sides with a dilute reactive polyurethane solution to provide a coated fabric 10;

(d) heating said coated fabric 10 at a predetermined temperature for a predetermined time to evaporate the solvent and cause the polyurethane mixture to be at least partially cured and to at least partially cover the cords 12, 14 of said fabric; and

(e) cooling said coated fabric 10.

2. The method in accordance with claim 1 wherein said section 26 of said tire fabric 10 is supported in a generally horizontal position between two spaced-apart transverse bars 42, 44 of a frame member 28 and the warp cords 12 of said fabric 10 are adjusted to hang evenly in parallel spaced relation between said bars 42, 44.

3. The method in accordance with claim 2 wherein after adjusting said warp cords 12 so that they hang evenly between said bars 42, 44 said fabric 10 is clamped at said bars 42, 44 and the coating of said fabric 10 is done by spraying said fabric 10 in the clamped condition.

4. The method in accordance with claim 3 wherein said frame member 28 with said coated fabric 10 clamped thereon is placed in an oven 64 for heating said coated fabric 10.

5. The method in accordance with claim 1 wherein said reactive polyurethane solution is prepared from a prepolymer and curative system used to cast a tire body 74.

6. The method in accordance with claim 5 wherein the curative is added to the prepolymer so that the ratio of amine groups of the curative to the free NCO groups of the prepolymer is in the range of from 0.8/1 to 1/1 with the free NCO groups being the excess of NCO groups of the polyisocyanate over the hydroxyl groups of the polymeric polyols in the prepolymer.

7. The method in accordance with claim 6 wherein said prepolymer is prepared separately by charging a reactor with a predetermined amount of polyol, degassing said polyol and then charging a required amount of diisocyanate to said degassed polyol at a predetermined temperature under agitation and with a full vacuum applied for a minimum period of time to mix the diisocyanate and polyol.

8. The method in accordance with claim 1 wherein said coated fabric 10 is heated at a temperature of about 250°F (100°C) for a period of time in the range of from about one-half hour to three hours.

9. The method in accordance with claim 7 wherein said curative solution is made by dissolving a predetermined amount of diamine in liquid ketone.

10. A tire 78 made by molding a toroidal shaped pneumatic tire comprised of a radially outer tread portion 82, a reinforcing tire cord belt 70 underlying said tread portion 82 and a tire casing 74

underlying said tread portion 82 and said belt 70, said method including the steps of claim 1 for processing said tire cord fabric 10 of said tire cord belt 70, and the steps of

(a) forming said tread portion 82 by placing elastomer forming material in a space 76 at the radially outer portion of said mold 84 and molding, reacting and at least partially curing said material;

(b) positioning said cord belt 70 on the inside surface 80 of said tread portion 82 with the edges 86, 88 equidistant from a centerplane A-A of said tire 78;

(c) fastening said cord belt 70 to said tread portion 82 with fastening means;

(d) assembling and inserting a core member 90 in said mold 84;

(e) forming said casing 74 by introducing and rotationally casting a predetermined quantity of liquid reaction mixture of elastomer forming material into the space 92 between said core 90, said mold 84 and said tread portion 82, reacting and at least partially curing said mixture to form said casing 74 overlapping and integrally adhered to said reinforcing cord belt 70 and said tread portion 82; and

(f) removing said formed tire 78 and core 90 from said mold 84 and removing said core 90 from said tire 78.

11. The method in accordance with claim 1 wherein after the fabric 10 is cooled it is cut into a cord belt 70 of a desired size.

12. The method in accordance with claim 11 wherein said fabric 10 is cut on a bias with the warp cords 12 at an angle greater than zero degrees to the edges 86, 88 of said belt 70.

13. The tire 78 in accordance with claim 10 wherein said tire cord belt 70 includes two or more layers of treated fabric 10 cut on a bias with the warp cords 12 at an angle greater than zero degrees to said edges 86, 88 of said belt 70 so that when said tire 78 is inflated the cords 12 may pantograph and provide for limited stretching of said belt 70.

14. A method of processing tire cord fabric 10 substantially as described herein or as shown in the accompanying drawings.

15. A tire 78 made substantially as described herein or as shown in the accompanying drawings.

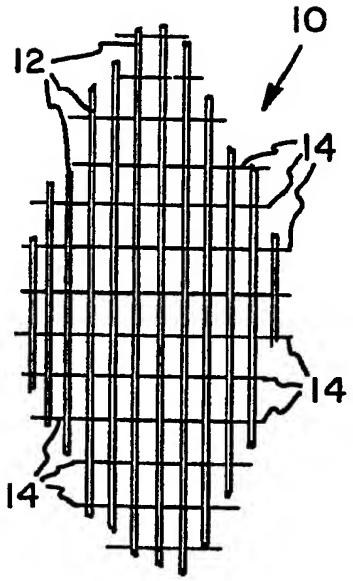

FIG. 1

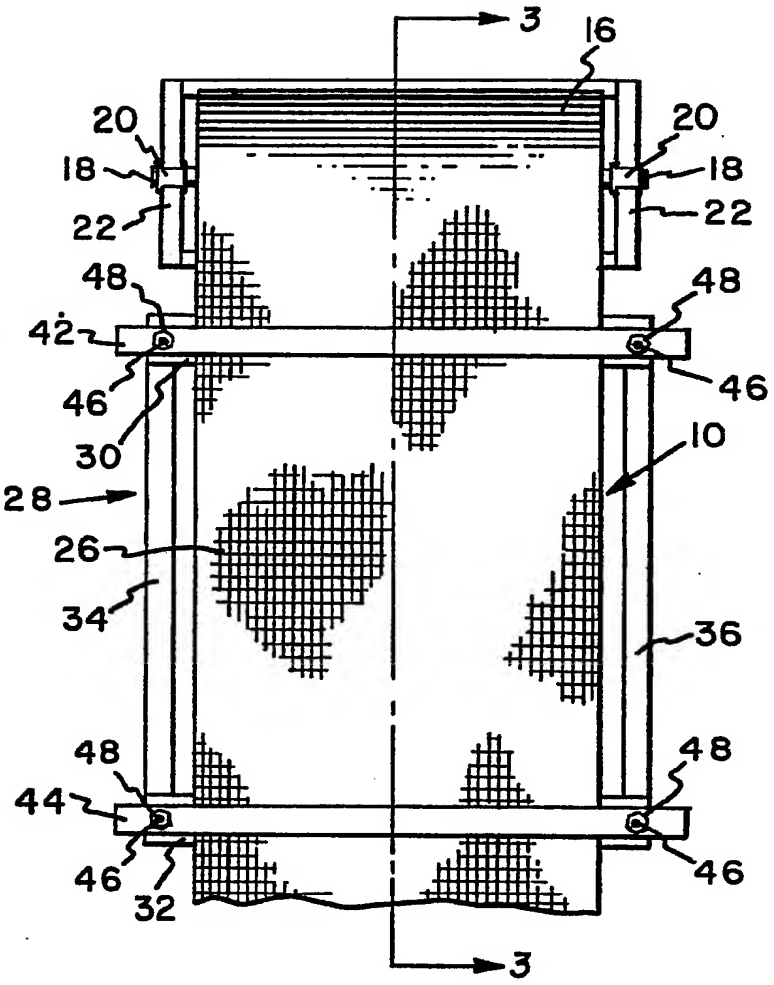

FIG. 2

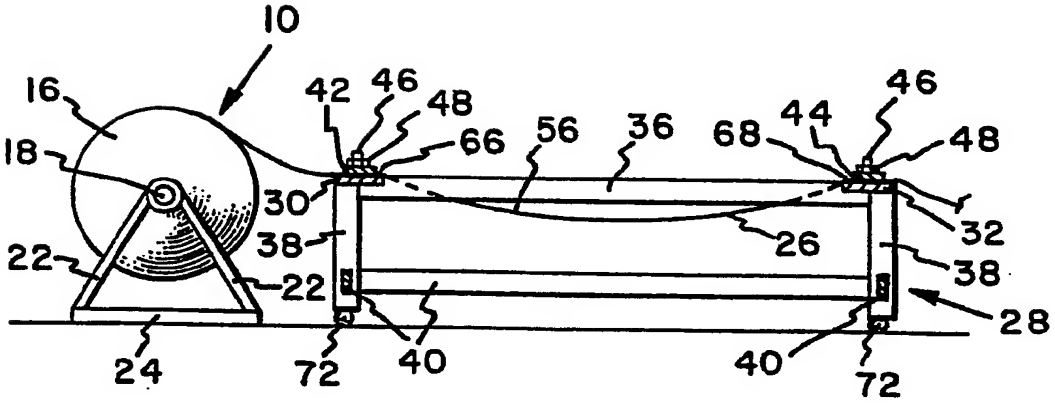

FIG. 3

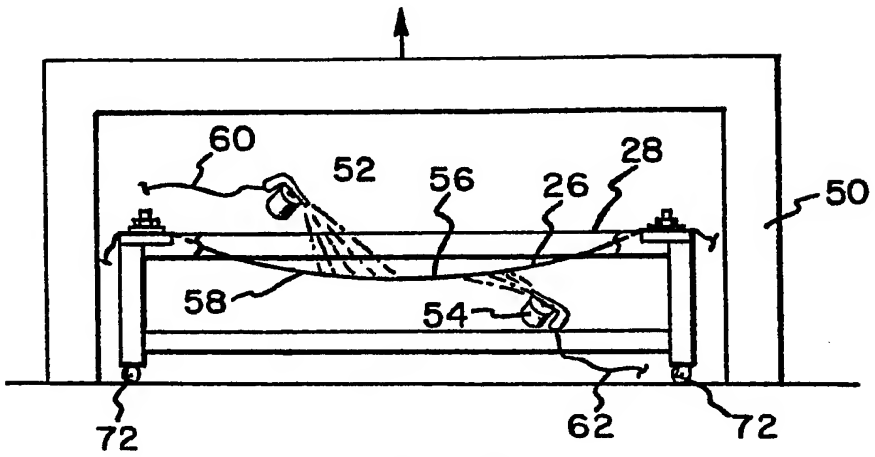

FIG. 4

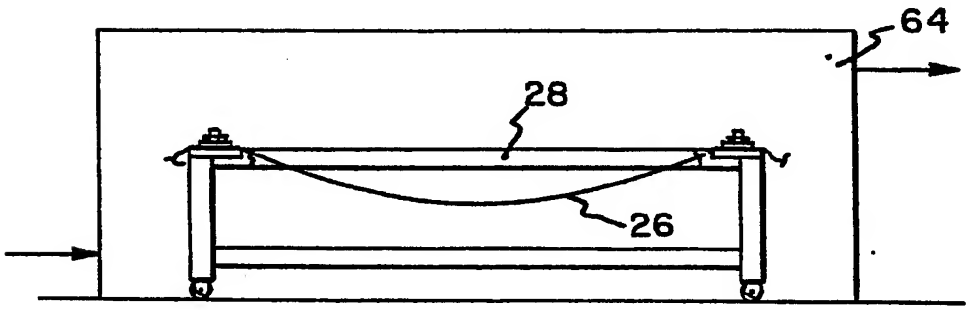

FIG. 5

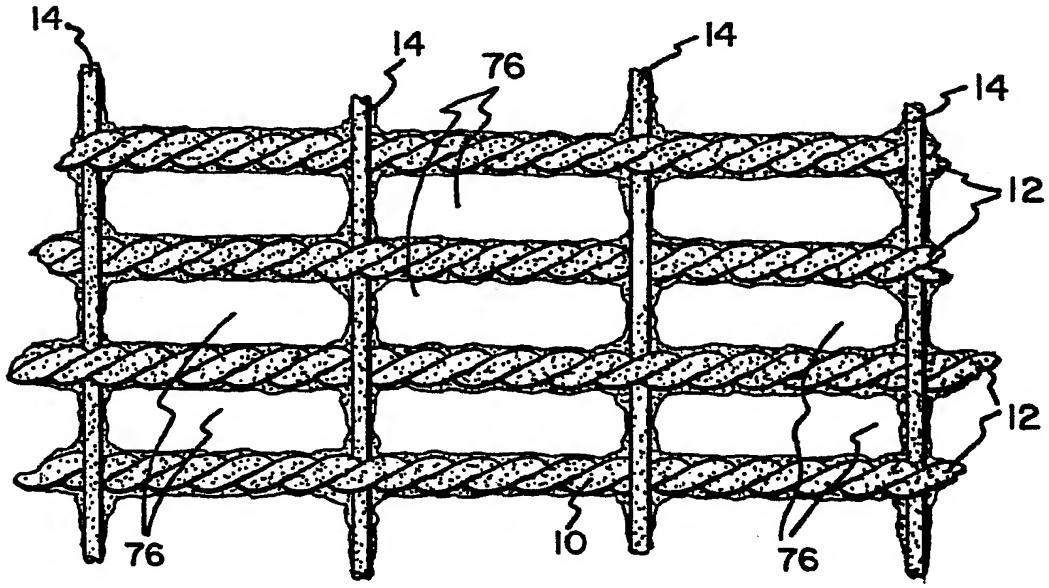

FIG. 6

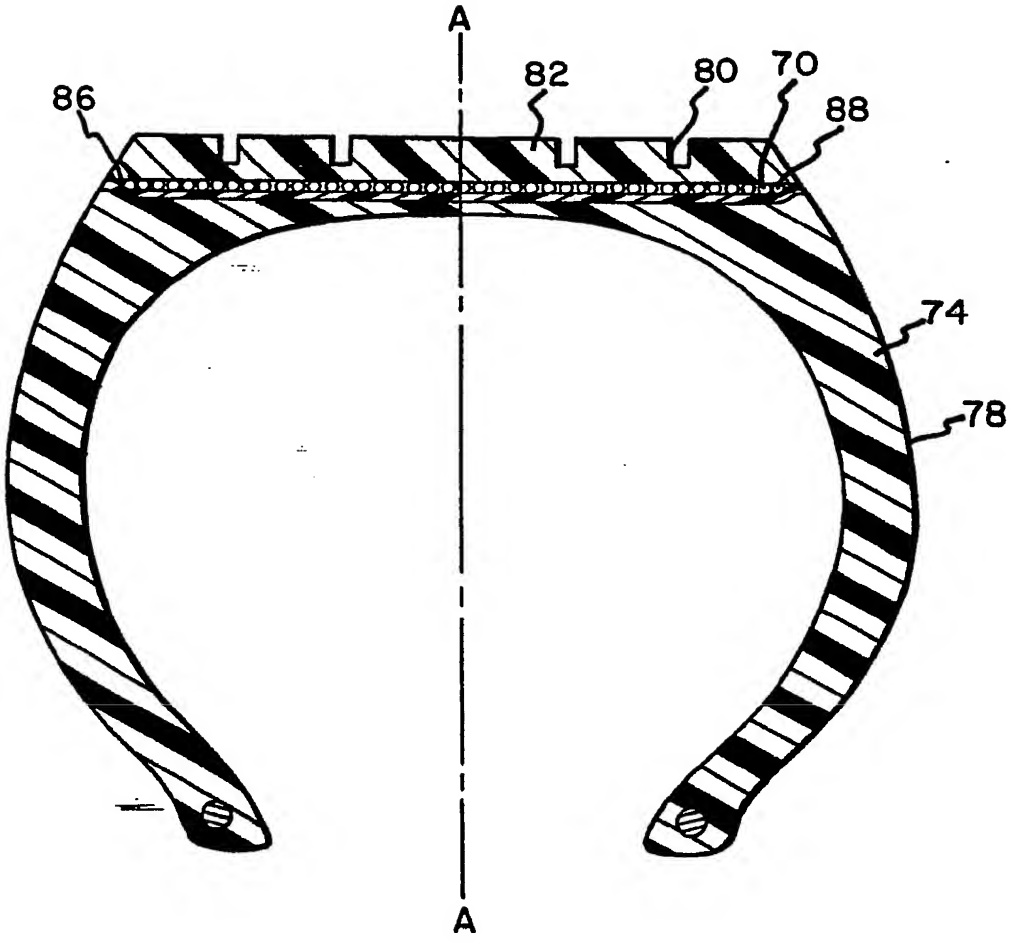

FIG. 7

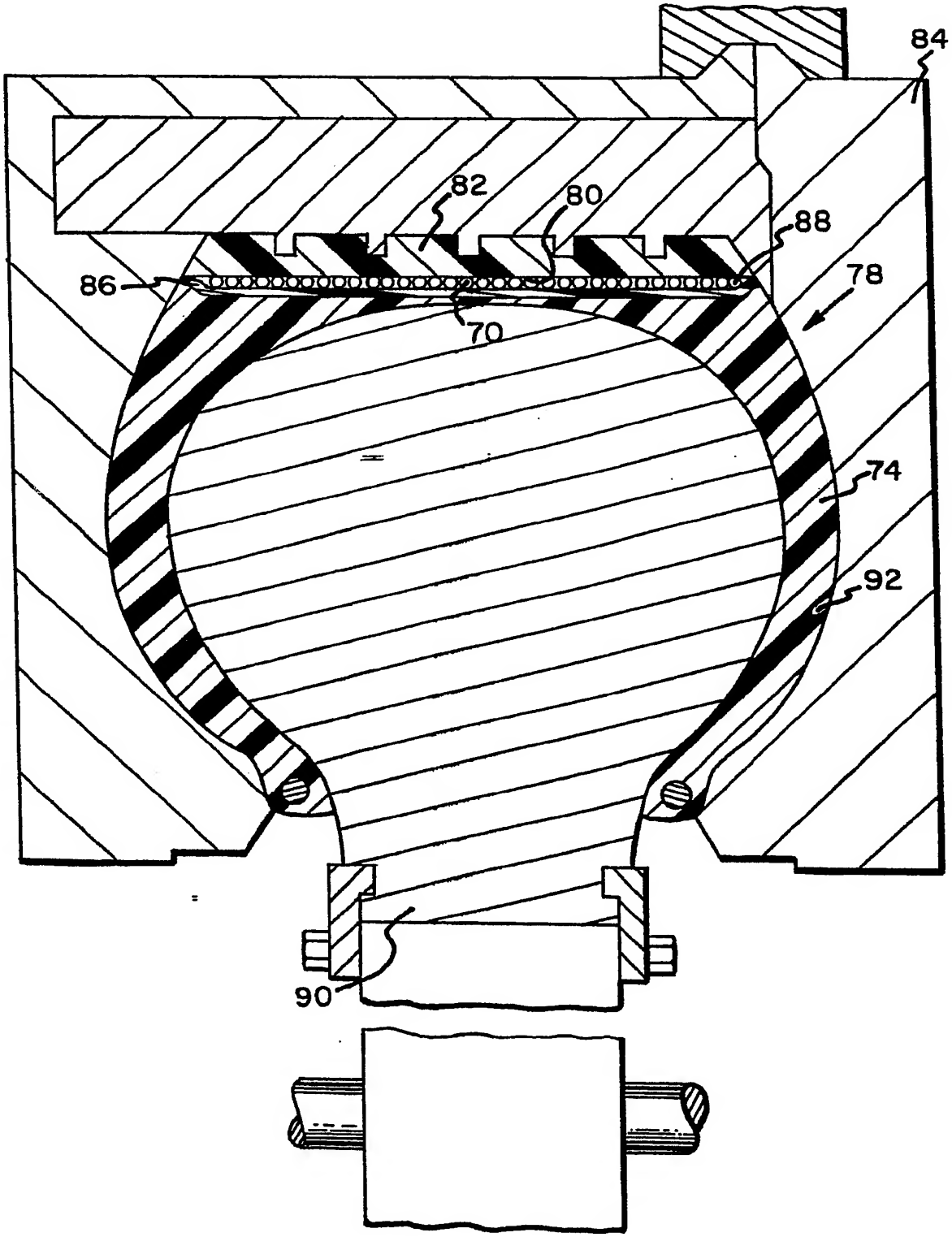

FIG. 8

0106778

European Patent Office

EUROPEAN SEARCH REPORT

Application number EP 83630102.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A	DE - A - 2 323 131 (W.R. GRACE & CO.) * Claims 1-6,8-10 *	1,5-9	B 29 H 17/28 B 60 C 9/18
A	US - A - 4 194 940 (DAMICO) * Claims *	1,5-9	
A	FR - A1 - 2 294 197 (E.C. DU PONT DE NEMOURS AND COMPANY) * Claim 8 *	1,5-9	
A	DE - A1 - 2 836 109 (PHOENIX AG) * Claims 1-3 *	10,13	
A	US - E - 21 269 (COPEMAN) * Page 2, lines 4-8; fig. 3,4 *	1,3,4	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) B 29 H B 32 B B 60 C C 08 J D 06 B D 06 M D 06 N
A	DE - B - 1 265 512 (UNITEX LIMITED) * Column 1, lines 13-21 *	1,5-7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	26-09-1983	WIDHALM

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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D : document cited in the application
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